Designation: A 671 – 96 (Reapproved 2001)

Standard Specification for Electric-Fusion-Welded Steel Pipe for Atmospheric and Lower Temperatures[1]

This standard is issued under the fixed designation A 671; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This specification[2] covers electric-fusion-welded steel pipe with filler metal added, fabricated from pressure vessel quality plate of several analyses and strength levels and suitable for high-pressure service at atmospheric and lower temperatures. Heat treatment may or may not be required to attain the desired properties or to comply with applicable code requirements. Supplementary requirements are provided for use when additional testing or examination is desired.

1.2 The specification nominally covers pipe 16 in. (405 mm) in outside diameter or larger and of ¼ in. (6.4 mm) wall thickness or greater. Pipe having other dimensions may be furnished provided it complies with all other requirements of this specification.

1.3 Several grades and classes of pipe are provided.

1.3.1 Grade designates the type of plate used as listed in 5.1.

1.3.2 Class designates the type of heat treatment performed during manufacture of the pipe, whether the weld is radiographically examined, and whether the pipe has been pressure tested as listed in 1.3.3.

1.3.3 Class designations are as follows (Note 1):

Class	Heat Treatment on Pipe	Radiography, see Section	Pressure Test, see:
10	none	none	none
11	none	9	none
12	none	9	8.3
13	none	none	8.3
20	stress relieved, see 5.3.1	none	none
21	stress relieved, see 5.3.1	9	none
22	stress relieved, see 5.3.1	9	8.3
23	stress relieved, see 5.3.1	none	8.3
30	normalized, see 5.3.2	none	none
31	normalized, see 5.3.2	9	none
32	normalized, see 5.3.2	9	8.3
33	normalized, see 5.3.2	none	8.3
40	normalized and tempered, see 5.3.3	none	none
41	normalized and tempered, see 5.3.3	9	none
42	normalized and tempered, see 5.3.3	9	8.3
43	normalized and tempered, see 5.3.3	none	8.3
50	quenched and tempered, see 5.3.4	none	none
51	quenched and tempered, see 5.3.4	9	none
52	quenched and tempered, see 5.3.4	9	8.3
53	quenched and tempered, see 5.3.4	none	8.3
60	normalized and precipitation heat treated	none	none
61	normalized and precipitation heat treated	9	none
62	normalized and precipitation heat treated	9	8.3
63	normalized and precipitation heat treated	none	8.3
70	quenched and precipitation heat treated	none	none
71	quenched and precipitation heat treated	9	none
72	quenched and precipitation heat treated	9	8.3
73	quenched and precipitation heat treated	none	8.3

NOTE 1—Selection of materials should be made with attention to temperature of service. For such guidance, Specification A 20/A 20M may be consulted.

1.4 The values stated in inch-pound units are to be regarded as the standard.

2. Referenced Documents

2.1 *ASTM Standards:*

A 20/A 20M Specification for General Requirements for Steel Plates for Pressure Vessels[3]

A 370 Test Methods and Definitions for Mechanical Testing of Steel Products[4]

A 435/A 435M Specification for Straight-Beam Ultrasonic Examination of Steel Plates[3]

A 530/A 530M Specification for General Requirements for Specialized Carbon and Alloy Steel Pipe[5]

A 577/A 577M Specification for Ultrasonic Angle-Beam Examination of Steel Plates[3]

A 578/A 578M Specification for Straight-Beam Ultrasonic Examination of Plain and Clad Steel Plates for Special Applications[3]

E 110 Test Method for Indentation Hardness of Metallic Materials by Portable Hardness Testers[6]

[1] This specification is under the jurisdiction of ASTM Committee A01 on Steel, Stainless Steel, and Related Alloys and is the direct responsibility of Subcommittee A01.09 on Carbon Steel Tubular Products.

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[2] For ASME Boiler and Pressure Vessel Code applications see related Specification SA-671 in Section II of that Code.

[3] *Annual Book of ASTM Standards*, Vol 01.04.

[4] *Annual Book of ASTM Standards*, Vol 01.03.

[5] *Annual Book of ASTM Standards*, Vol 01.01.

[6] *Annual Book of ASTM Standards*, Vol 03.01.

E 165 Test Method for Liquid Penetrant Inspection[7]
E 350 Test Method for Chemical Analysis of Carbon Steel, Low-Alloy Steel, Silicon Electrical Steel, Ingot Iron, and Wrought Iron[8]
E 709 Practice for Magnetic Particle Examination[7]

2.2 *Plate Steels:*

A 203/A 203M Specification for Pressure Vessel Plates, Alloy Steel, Nickel[3]
A 285/A 285M Specification for Pressure Vessel Plates, Carbon Steel, Low- and Intermediate-Tensile Strength[3]
A 299/A 299M Specification for Pressure Vessel Plates, Carbon Steel, Manganese-Silicon[3]
A 353/A 353M Specification for Pressure Vessel Plates, Alloy Steel, 9 Percent Nickel, Double-Normalized and Tempered[3]
A 442/A 442M Specification for Pressure Vessel Plates, Carbon Steel, Improved Transition Properties[3]
A 515/A 515M Specification for Pressure Vessel Plates, Carbon Steel, for Intermediate-and Higher-Temperature Service[3]
A 516/A 516M Specification for Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service[3]
A 517/A 517M Specification for Pressure Vessel Plates, Alloy Steel, High-Strength, Quenched and Tempered[3]
A 537/A 537M Specification for Pressure Vessel Plates, Heat-Treated, Carbon-Manganese-Silicon Steel[3]
A 553/A 553M Specification for Pressure Vessel Plates, Alloy Steel, Quenched and Tempered 8 and 9 Percent Nickel[3]
A 645/A 645M Specification for Pressure Vessel Plates, 5 Percent Nickel Alloy Steel, Specially Heat Treated[3]
A 736/A 736M Specification for Pressure Vessel Plates, Low-Carbon Age-Hardening, Nickel-Copper-ChromiumMolybdenum-Columbium and Nickel-Copper-Manganese-Molybdenum-Columbium Alloy Steel[3]

2.3 *ASME Boiler and Pressure Vessel Code:*[9]

Section II, Material Specifications
Section III, Nuclear Vessels
Section VIII, Unfired Pressure Vessels
Section IX, Welding Qualifications

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *lot*—a lot shall consist of 200 ft (61 m) or fraction thereof of pipe from the same heat of steel.

3.1.2 The description of a lot may be further restricted by the use of Supplementary Requirement S14.

4. Ordering Information

4.1 The inquiry and order for material under this specification should include the following information:

4.1.1 Quantity (feet, metres, or number of lengths),
4.1.2 Name of material (steel pipe, electric-fusionwelded),
4.1.3 Specification number,
4.1.4 Grade and class designations (see 1.3),
4.1.5 Size (inside or outside diameter, nominal or minimum wall thickness),
4.1.6 Length (specific or random),
4.1.7 End finish (11.4),
4.1.8 Purchase options, if any (see 5.2.3 and 11.3 of this specification. See also Specification A 530/A 530M),
4.1.9 Supplementary requirements, if any.

5. Materials and Manufacture

5.1 *Materials*—The steel plate material shall conform to the requirement of the applicable plate specification for the pipe grade ordered as listed in Table 1.

5.2 *Welding*:

5.2.1 The joints shall be double-welded, full-penetration welds made in accordance with procedures and by welders or welding operators qualified in accordance with the ASME Boiler and Pressure Vessel Code, Section IX.

5.2.2 The welds shall be made either manually or automatically by an electric process involving the deposition of filler metal.

5.2.3 As welded, the welded joint shall have positive reinforcement at the center of each side of the weld, but no more than ⅛ in. (3.2 mm). This reinforcement may be removed at the manufacturer's option or by agreement between the manufacturer and purchaser. The contour of the reinforcement

TABLE 1 Plate Specifications

Pipe Grade	Type of Steel	ASTM Specification	
		No.	Grade
CA 55	plain carbon	A 285/A 285M	C
CB 60	plain carbon, killed	A 515/A 515M	60
CB 65	plain carbon, killed	A 515/A 515M	65
CB 70	plain carbon, killed	A 515/A 515M	70
CC 60	plain carbon, killed, fine grain	A 516/A 516M	60
CC 65	plain carbon, killed, fine grain	A 516/A 516M	65
CC 70	plain carbon, killed, fine grain	A 516/A 516M	70
CD 70	manganese-silicon, normalized	A 537/A 537M	1
CD 80	manganese-silicon, quenched and tempered	A 537/A 537M	2
CE 55	plain carbon	A 442/A 442M	55
CE 60	plain carbon	A 442/A 442M	60
CF 65	nickel steel	A 203/A 203M	A
CF 70	nickel steel	A 203/A 203M	B
CF 66	nickel steel	A 203/A 203M	D
CF 71	nickel steel	A 203/A 203M	E
CJ 101	alloy steel, quenched and tempered	A 517/A 517M	A
CJ 102	alloy steel, quenched and tempered	A 517/A 517M	B
CJ 103	alloy steel, quenched and tempered	A 517/A 517M	C
CJ 104	alloy steel, quenched and tempered	A 517/A 517M	D
CJ 105	alloy steel, quenched and tempered	A 517/A 517M	E
CJ 106	alloy steel, quenched and tempered	A 517/A 517M	F
CJ 107	alloy steel, quenched and tempered	A 517/A 517M	G
CJ 108	alloy steel, quenched and tempered	A 517/A 517M	H
CJ 109	alloy steel, quenched and tempered	A 517/A 517M	J
CJ 110	alloy steel, quenched and tempered	A 517/A 517M	K
CJ 111	alloy steel, quenched and tempered	A 517/A 517M	L
CJ 112	alloy steel, quenched and tempered	A 517/A 517M	M
CJ 113	alloy steel, quenched and tempered	A 517/A 517M	P
CK 75	carbon-manganese-silicon	A 299/A 299M	
CP65	alloy steel, age hardening, normalized and precipitation heat treated	A 736/A 736M	2
CP75	alloy steel, age hardening, quenched and precipitation heat treated	A 736/A 736M	3

[7] *Annual Book of ASTM Standards*, Vol 03.03.
[8] *Annual Book of ASTM Standards*, Vol 03.05.
[9] Available from ASME International, Three Park Avenue, New York, NY 10016–5990..

shall be smooth and the deposited metal shall be fused smoothly and uniformly into the plate surface.

5.2.4 When radiographic examination in accordance with 9.1 is to be used, the weld reinforcements shall be governed by the more restrictive provision UW–51 of Section VIII of the ASME Boiler and Pressure Vessel Code instead of 5.2.3 of this specification.

5.3 *Heat Treatment*—All classes other than 10, 11, 12, and 13 shall be heat treated in furnace controlled to ±25°F (±14°C) and equipped with a recording pyrometer so that heating records are available. Heat treating after forming and welding shall be to one of the following:

5.3.1 Classes 20, 21, 22, and 23 pipe shall be uniformly heated within the post-weld heat-treatment temperature range indicated in Table 2 for a minimum of 1 h/in. of thickness or for 1 h, whichever is greater.

5.3.2 Classes 30, 31, 32, and 33, pipe shall be uniformly heated to a temperature in the austenitizing range and not exceeding the maximum normalizing temperature indicated in Table 2 and subsequently cooled in air at room temperature.

5.3.3 Classes 40, 41, 42, and 43 pipe shall be normalized in accordance with 5.3.2. After normalizing, the pipe shall be reheated to the tempering temperature indicated in Table 2 as a minimum and held at temperature for a minimum of ½ h/in. of thickness or for ½ h, whichever is greater, and air cooled.

5.3.4 Classes 50, 51, 52, and 53 pipe shall be uniformly heated to a temperature in the austenitizing range, and not exceeding the maximum quenching temperature indicated in Table 2 and subsequently quenched in water or oil. After quenching, the pipe shall be reheated to the tempering temperature indicated in Table 2 as a minimum and held at that temperature for a minimum of ½h/in. of thickness or for ½ h, whichever is greater, and air cooled.

5.3.5 Classes 60, 61, 62, and 63 pipe shall be normalized in accordance with 5.3.2. After normalizing, the pipe shall be precipitation heat treated in the range shown in Table 2 for a time to be determined by the manufacturer.

5.3.6 Classes 70, 71, 72, and 73 pipe shall be uniformly heated to a temperature in the austenitizing range, not exceeding the maximum quenching temperature indicated in Table 2, and subsequently quenched in water or oil. After quenching the pipe shall be reheated into the precipitation heat treating range indicated in Table 2 for a time to be determined by the manufacturer.

TABLE 2 Heat Treatment Parameters

Pipe Grade[A]	ASTM Specification and Grade	Post-Weld Heat-Treatment Temperature Range °F(°C)	Normalizing Temperature, max, °F(°C)	Quenching Temperature, max, °F(°C)	Tempering Temperature, min, °F(°C)	Precipitation Heat Treatment Temperature Range °F(°C)
CA 55	A 285/A 285M (C)	1100–1250 (590–680)	1700 (925)	...	...	...
CB 60	A 515/A 515M (60)	1100–1250 (590–680)	1750 (950)	...	...	...
CB 65	A 515/A 515M (65)	1100–1250 (590–680)	1750 (950)	...	...	...
CB 70	A 515/A 515M (70)	1100–1250 (590–680)	1750 (950)	...	...	...
CC 60	A 516/A 516M (60)	1100–1250 (590–680)[B]	1700 (925)	1650 (900)	1200 (650)[C]	...
CC 65	A 516/A 516M (65)	1100–1250 (590–680)[B]	1700 (925)	1650 (900)	1200 (650)	...
CC 70	A 516/A 516M (70)	1100–1250 (590–680)[B]	1700 (925)	1650 (900)	1200 (650)	...
CD 70	A 537/A 537M (1)	1100–1250 (590–680)	1700 (925)	...	...	...
CD 80	A 537/A 537M (2)	1100–1250 (590–680)[B]	...	1650 (900)	1100 (590)	...
CE 55	A 442/A 442M (55)	1100–1250 (590–680)[B]	1700 (925)	1650 (900)	1200 (650)	...
CE 60	A 442/A 442M (60)	1100–1250 (590–680)[B]	1700 (925)	1650 (900)	1200 (650)	...
CF 65	A 203/A 203M (A)	1100–1175 (590–635)	1750 (950)	...	...	...
CF 70	A 203/A 203M (B)	1100–1175 (590–635)	1750 (950)	...	...	...
CF 66	A 203/A 203M (D)	1100–1175 (590–635)	1750 (950)	...	...	...
CF 71	A 203/A 203M (E)	1100–1175 (590–635)	1750 (950)	...	...	...
CJ 101	A 517/A 517M (A)	1000–1100 (540–590)	...	1725 (940)[D]	1150 (620)	...
CJ 102	A 517/A 517M (B)	1000–1100 (540–590)	...	1725 (940)[D]	1150 (620)	...
CJ 103	A 517/A 517M (C)	1000–1100 (540–590)	...	1725 (940)[D]	1150 (620)	...
CJ 104	A 517/A 517M (D)	1000–1100 (540–590)	...	1725 (940)[D]	1150 (620)	...
CJ 105	A 517/A 517M (E)	1000–1100 (540–590)	...	1725 (940)[D]	1150 (620)	...
CJ 106	A 517/A 517M (F)	1000–1100 (540–590)	...	1725 (940)[D]	1150 (620)	...
CJ 107	A 517/A 517M (G)	1000–1100 (540–590)	...	1725 (940)[D]	1150 (620)	...
CJ 108	A 517/A 517M (H)	1000–1100 (540–590)	...	1725 (940)[D]	1150 (620)	...
CJ 109	A 517/A 517M (J)	1000–1100 (540–590)	...	1725 (940)[D]	1150 (620)	...
CJ 110	A 517/A 517M (K)	1000–1100 (540–590)	...	1725 (940)[D]	1150 (620)	...
CJ 111	A 517/A 517M (L)	1000–1100 (540–590)	...	1725 (940)[D]	1150 (620)	...
CJ 112	A 517/A 517M (M)	1000–1100 (540–590)	...	1725 (940)[D]	1150 (620)	...
CJ 113	A 517/A 517M (P)	1000–1100 (540–590)	...	1725 (940)[D]	1150 (620)	...
CK 75	A 299/A 299M	1100–1250 (590–680)	1700 (925)	...	...	...
CP65	A 736/A 736M (2)	1000–1175 (540–635)	1725 (940)	...	...	1000–1200 (540–650)
CP75	A 736/A 736M (3)	1000–1175 (540–635)	...	1725 (940)	...	1000–1225 (540–665)

[A] Numbers indicate minimum tensile strength in ksi.
[B] In no case shall the post-weld heat-treatment temperature exceed the mill tempering temperature.
[C] Tempering range 1100 to 1300, if accelerated cooling utilized per Specification A 516/A 516M.
[D] Per ASME Section VIII Specification A 517/A 517M specified 1650 (900) minimum quenching temperature.

6. General Requirements for Delivery

6.1 Material furnished to this specification shall conform to the applicable requirements of the current edition of Specification A 530/A 530M unless otherwise provided herein.

7. Chemical Composition

7.1 *Product Analysis of Plate*—The pipe manufacturer shall make an analysis of each mill heat of plate material. The product analysis so determined shall meet the requirements of the plate specification to which the material was ordered.

7.2 *Product Analyses of Weld*—The pipe manufacturer shall make an analysis of finished deposited weld material from each 200 ft (61 m) or fraction thereof. Analyses shall conform to the welding procedure for deposited weld metal.

7.3 Analysis may be taken from the mechanical test specimens. The results of the analyses shall be reported to the purchaser.

8. Mechanical Requirements

8.1 *Tension Test*:

8.1.1 *Requirements*——Transverse tensile properties of the welded joint shall meet the minimum requirements for ultimate tensile strength of the specified plate material. In addition for Grades CD and CJ, when these are of Class 3x, 4x, or 5x, and Grade CP of Class 6x and 7x, the transverse tensile properties of the base plate shall be determined on specimens cut from the heat-treated pipe. These properties shall meet the mechanical test requirements of the plate specification.

8.1.2 *Number of Tests*—One test specimen of weld metal and one specimen of base metal, if required by 8.1.1, shall be made and tested to represent each lot of finished pipe.

8.1.3 *Test Specimen Location and Orientation*—The test specimens shall be taken transverse to the weld at the end of the finished pipe and may be flattened cold before final machining to size.

8.1.4 *Test Method*—The test specimen shall be made in accordance with QW-150 in Section IX of the ASME Boiler and Pressure Vessel Code. The test specimen shall be tested at room temperature in accordance with Test Methods and Definitions A 370.

8.2 *Transverse Guided Weld Bend Test*:

8.2.1 *Requirements*—The bend test shall be acceptable if no cracks or other defects exceeding ⅛ in. (3.2 mm) in any direction are present in the weld metal or between the weld and the base metal after bending. Cracks that originate along the edges of the specimen during testing, and that are less than ¼ in. (6.4 mm) measured in any direction shall not be considered.

8.2.2 *Number of Tests*—One test (two specimens) shall be made to represent each lot of finished pipe.

8.2.3 *Test Specimen Location and Orientation*—Two bend test specimens shall be taken transverse to the weld at the end of the finished pipe. As an alternative, by agreement between the purchaser and the manufacturer, the test specimens may be taken from a test plate of the same material as the pipe, the test plate being attached to the end of the cylinder and welded as a prolongation of the pipe longitudinal seam.

8.2.4 *Test Method*—The test requirements of A 370, S9.1.7 shall be met. For wall thicknesses over ⅜ in. (9.5 mm) but less than ¾ in. (19.0 mm) side-bend tests may be made instead of the face and root-bend tests. For wall thicknesses ¾ in. and over both specimens shall be subjected to the side-bend test.

8.3 *Pressure Test*—Classes X2 and X3 pipe shall be tested in accordance with Specification A 530/A 530M, Section 6.

9. Radiographic Examination

9.1 The full length of each weld of Classes X1 and X2 shall be radiographically examined in accordance with and meet the requirements of ASME Boiler and Pressure Vessel Code, Section VIII, Paragraph UW–51.

9.2 Radiographic examination may be performed prior to heat treatment.

10. Rework

10.1 *Elimination of Surface Imperfections*—Unacceptable surface imperfections shall be removed by grinding or machining. The remaining thickness of the section shall be no less than the minimum specified in Section 11. The depression after grinding or machining shall be blended uniformly into the surrounding surface.

10.2 *Repair of Base Metal Defects by Welding*:

10.2.1 The manufacturer may repair, by welding, base metal where defects have been removed, provided the depth of the repair cavity as prepared for welding does not exceed ⅓of the nominal thickness and the requirements of 10.2.2, 10.2.3, 10.2.4, 10.2.5 and 10.2.6 are met. Base metal defects in excess of these may be repaired with prior approval of the customer.

10.2.2 The defect shall be removed by suitable mechanical or thermal cutting or gouging methods and the cavity prepared for repair welding.

10.2.3 The welding procedure and welders or welding operators are to be qualified in accordance with Section IX of the ASME Boiler and Pressure Vessel Code.

10.2.4 The full length of the repaired pipe shall be heat treated after repair in accordance with the requirements of the pipe class specified.

10.2.5 Each repair weld of a defect where the cavity, prepared for welding, has a depth exceeding the lesser of ⅜ in. (9.5 mm) or 10 % of the nominal thickness shall be examined by radiography in accordance with the methods and the acceptance standards of Section 9.

10.2.6 The repair surface shall be blended uniformly into the surrounding base metal surface and examined and accepted in accordance with Supplementary Requirements S6 or S8.

10.3 *Repair of Weld Metal Defects by Welding*:

10.3.1 The manufacturer may repair weld metal defects if he meets the requirements of 10.2.3, 10.2.4, 10.3.2, 10.3.3 and 10.4.

10.3.2 The defect shall be removed by suitable mechanical or thermal cutting or gouging methods and the repair cavity examined and accepted in accordance with Supplementary Requirements S7 or S9.

10.3.3 The weld repair shall be blended uniformly into the surrounding metal surfaces and examined and accepted in accordance with 9.1 and with Supplementary Requirements S7 or S9.

10.4 *Retest*—Each length of repaired pipe of a class requiring a pressure test shall be hydrostatically tested following repair.

11. Dimensions, Mass and Permissible Variations

11.1 The wall thickness and weight for welded pipe furnished to this specification shall be governed by the requirements of the specification to which the manufacturer ordered the plate.

11.2 Permissible variations in dimensions at any point in a length of pipe shall not exceed the following:

11.2.1 *Outside Diameter*—Based on circumferential measurement ± 0.5 % of the specified outside diameter.

11.2.2 *Out-of-Roundness*—Difference between major and minor outside diameters, 1 %.

11.2.3 *Alignment*—Using a 10-ft (3-m) straight edge placed so that both ends are in contact with the pipe, ⅛ in. (3.2 mm).

11.2.4 *Thickness*—The minimum wall thickness at any point in the pipe shall not be more than 0.01 in. (0.25 mm) under the specified nominal thickness.

11.3 Circumferential welded joints of the same quality as the longitudinal joints shall be permitted by agreement between the manufacturer and the purchaser.

11.4 Lengths with unmachined ends shall be within −0, +½ in. (−0, +13 mm) of that specified. Lengths with machined ends shall be as agreed between the manufacturer and the purchaser.

12. Workmanship, Finish, and Appearance

12.1 The finished pipe shall be free of injurious defects and shall have a workmanlike finish. This requirement is to mean the same as the identical requirement that appears in Specification A 20/A 20M with respect to steel plate surface finish.

13. Product Marking

13.1 In addition to the marking provision of Specification A 530/A 530M, class marking in accordance with 1.3.3 shall follow the grade marking, for example, CC 70–10.

13.2 *Bar Coding*—In addition to the requirements in 13.1, bar coding is acceptable as a supplemental identification method. The purchaser may specify in the order a specific bar coding system to be used.

SUPPLEMENTARY REQUIREMENTS

One or more of the following supplementary requirements shall be applied only when specified by the purchaser in the inquiry, contract, or order. Details of these supplementary requirements shall be agreed upon in writing by the manufacturer and purchaser. Supplementary requirements shall in no way negate any requirement of the specification itself.

S1. Tension and Bend Tests

S1.1 Tension tests in accordance with 8.1 and bend tests in accordance with 8.2 shall be made on specimens representing each length of pipe.

S2. Charpy V-Notch Test

S2.1 *Requirements*—The acceptable test energies for material shown in Specification A 20/A 20M shall conform to the energy values shown in Specification A 20/A 20M.

S2.1.1 Materials not listed in Specification A 20/A 20M shall be in accordance with the purchase order requirements.

S2.2 *Number of Specimens*—Each test shall consist of at least three specimens.

S2.2.1 One base metal test shall be made from one pipe length per heat-treat charge per nominal wall thickness. For pipe from Classes 10, 11, 12, and 13, one base metal test shall be made per heat per size and per wall thickness.

S2.2.2 One weld-metal test shall be made in accordance with UG–84 of Section VIII of the ASME Boiler and Pressure Vessel Code.

S2.2.3 One heat-affected-zone test shall be made in accordance with UG–84 of Section VIII of the ASME Boiler and Pressure Vessel Code.

S2.3 *Test Specimen Location and Orientation:*

S2.3.1 Specimens for base-metal tests in Grades CA, CB, CC, and CE in the as rolled stress relieved or normalized condition (classes of the 10, 20, 30, and 40 series) shall be taken so that the longitudinal axis of the specimen is parallel to the longitudinal axis of the pipe.

S2.3.2 Base-metal specimens of quench and tempered pipe, when the quenching and tempering follows the welding operation, shall be taken in accordance with the provision of N330 of Section III of the ASME Boiler and Pressure Vessel Code.

S2.4 *Test Method*—The specimen shall be Charpy-V Type A in accordance with Methods and Definitions A 370. The specimens shall be tested in accordance with Methods and Definitions A 370. Unless otherwise indicated by the purchaser, the test temperature shall be as given in Specification A 20/A 20M for those base materials covered by Specification A 20/A 20M. For materials not covered by Specification A 20/A 20M the test temperature shall be 10°F (−12°C) unless otherwise stated in the purchase order.

S3. Hardness Test

S3.1 Hardness tests shall be made in accordance with Methods and Definitions A 370 or Test Method E 110 across the welded joint of both ends of each length of pipe. In addition, hardness tests shall be made to include the heat-affected zone if so required by the purchaser. The maximum acceptable hardness shall be as agreed upon between the manufacturer and the purchaser.

S3.2 As an alternative to the heat-affected zone hardness, by agreement between the manufacturer and purchaser, maximum heat-affected zone hardness may be specified for the procedure test results.

S4. Product Analysis

S4.1 Product analyses in accordance with 7.1 shall be made on each 500 ft (152 m) of pipe of fraction thereof, or alternatively, on each length of pipe as designated in the order.

S5. Metallography

S5.1 The manufacturer shall furnish one photomicrograph to show the microstructure at 100× magnification of the weld metal or base metal of the pipe in the as-finished condition. The purchaser shall state in the order: the material, base metal or weld, and the number and locations of tests to be made. This test is for information only.

S6. Magnetic Particle Examination of Base Metal

S6.1 All accessible surfaces of the pipe shall be examined in accordance with Practice E 709. Accessible is defined as: All outside surfaces, all inside surfaces of pipe 24 in. (610 mm) in diameter and greater, and inside surfaces of pipe less than 24 in. in diameter for a distance of 1 pipe diameter from the ends.

S6.2 *Acceptance Standards*—The following relevant indications are unacceptable:

S6.2.1 Any linear indications greater than 1⁄16 in. (1.6 mm) long for materials less than 5⁄8in (15.9 mm) thick; greater than 1⁄8in. (3.2 mm) long for materials from 5⁄8in. thick to under 2 in. (51 mm) thick; and greater than 3⁄16 in. (4.8 mm) long for materials 2 in. thick or greater.

S6.2.2 Rounded indications with dimensions greater than 1⁄8 in. (3.2 mm) for thicknesses less than 5⁄8 in. (15.9 mm), and greater than 3⁄16 in. (4.8 mm) for thicknesses 5⁄8 in. and greater.

S6.2.3 Four or more indications in any line separated by 1⁄16 in. (1.6 mm) or less edge-to-edge.

S6.2.4 Ten or more indications in any 6 $in.^2$(39 cm^2) of surface with the major dimension of this area not to exceed 6 in. (152 mm) when it is taken in the most unfavorable orientation relative to the indications being evaluated.

S7. Magnetic Particle Examination of Weld Metal

S7.1 All accessible welds shall be examined in accordance with Practice E 709. Accessible is defined as: All outside surfaces, all inside surfaces of pipe 24 in. (610 mm) in diameter and greater, and inside surfaces of pipe less than 24 in. in diameter for a distance of one pipe diameter from the ends.

S7.2 *Acceptance Criteria*—The following relevant indications are unacceptable:

S7.2.1 Any cracks and linear indications.

S7.2.2 Rounded indications with dimensions greater than 3⁄16 in. (4.8 mm).

S7.2.3 Four or more indications in any line separated by 1⁄16 in. (1.6 mm) or less edge-to-edge.

S7.2.4 Ten or more indications in any 6 $in.^2$(39 cm^2) of surface with the major dimension of this area not to exceed 6 in. (152 mm) when it is taken in the most unfavorable orientation relative to the indications being evaluated.

S8. Liquid Penetrant Examination of Base Metal

S8.1 All accessible surfaces of the pipe shall be examined in accordance with Practice E 165. Accessible is as defined in S7.1.

S8.2 The acceptance criteria shall be in accordance with S6.2.

S9. Liquid Penetrant Examination of Weld Metal

S9.1 All accessible surfaces of the pipe shall be examined in accordance with Practice E 165. Accessible is as defined in S7.1.

S9.2 The acceptance criteria shall be in accordance with S7.2.

S10. Straight Beam Ultrasonic Examination of Flat Plate—UT 1

S10.1 The plate shall be examined and accepted in accordance with Specification A 435/A 435M except that 100 % of one surface shall be scanned by moving the search unit in parallel paths with not less than 10 % overlap.

S11. Straight Beam Ultrasonic Examination of Flat Plate—UT 2

S11.1 The plate shall be examined in accordance with Specification A 578/A 578M except that 100 % of one surface shall be scanned and the acceptance criteria shall be as follows:

S11.1.1 Any area, where one or more discontinuities produce a continuous total loss of back reflection accompanied by continuous indications on the same plane that cannot be encompassed within a circle whose diameter is 3 in. (76.2 mm) or one half of the plate thickness, whichever is greater, is unacceptable.

S11.1.2 In addition, two or more discontinuities on the same plane and having the same characteristics but smaller than described above shall be unacceptable unless separated by a minimum distance equal to the largest diameter of the larger discontinuity or unless they may be collectively encompassed by the circle described above.

S12. Angle Beam Ultrasonic Examination (Plate Less than 2 in. (50.8 mm) Thick)—UT 3

S12.1 The plate shall be examined in accordance with Specification A 577/A 577M except that the calibration notch shall be vee shaped and the acceptance criteria shall be as follows: Any area showing one or more reflections producing indications whose amplitude exceeds that of the calibration notch is unacceptable.

S13. Repair Welding

S13.1 Repair of base metal defects by welding shall be done only with customer approval.

S14. Description of Term

S14.1 *lot*—all pipe of the same mill heat of plate material and wall thickness (within ±¼in. (6.4 mm)) heat treated in one furnace charge. For pipe that is not heat treated or that is heat treated in a continuous furnace, a lot shall consist of each 200 ft (61 m) or fraction thereof of all pipe of the same mill heat of plate material and wall thickness (within ±¼ in. (6.4 mm)), subjected to the same heat treatment. For pipe heat treated in a batch-type furnace that is automatically controlled within a 50°F (28°C) range and is equipped with recording pyrometers

so that heating records are available, a lot shall be defined the same as for continuous furnaces.